Issues in Environmental Justice Research

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Abstract

This paper examines some of the problems and constraints in conducting environmental justice research. The disproportionate impact of environmental threats on public health, especially on minority and low-income populations, is the key concept in environmental justice. After a brief review of environmental equity, public policies, and the environmental justice movement, the paper highlights some of the empirical and GIS-related research supporting and/or refuting environmental justice claims. The constraints include the choice of the specific environmental threat or threats and their comparability; the geographic scale of analysis; the particular subpopulation selected; and the time frame for the analysis. The paper concludes with a suggestion to move from static interpretations of environmental injustices to more dynamic approaches that rank the relative hazardousness of spatial units (census tracts, counties, etc.) based on the magnitude and toxicity of releases within them, rather than the mere presence or absence of industrial facilities. Measures of relative risk provide more meaningful indicators of the potential sources of environmental threats within communities and can make it easier to understand local sensitivity to claims of environmental injustice.

Keywords: environmental justice, toxic releases, geographic scale

Introduction

Environmental equity—preventing disproportionate effects of environmental degradation on people and places—has been a federal concern for at least three decades (1–3). In the early 1990s, coalitions of civil rights and environmental activists transformed environmental equity concerns into the environmental justice movement, ostensibly because of concerns about the placement of toxic waste facilities in low-income and minority communities (4–8). The First National People of Color Environmental Leadership Summit was held in 1991 and immediately was followed by the establishment of the US Environmental Protection Agency's (EPA's) Office of Environmental Equity. In 1994, environmental justice was institutionalized within the federal government through Executive Order 12898, which focused federal attention on human-health and environmental conditions in minority and low-income communities. It also provided for greater public participation and access to environmental information in these impacted communities.

While the environmental justice movement has been successful in bringing the issue to the attention of policy makers and the public, there is some skepticism as to whether or not injustices do, in fact, exist. In other words, there is a federal policy in place despite little empirical verification of the true extent of the problem. While we may see a correlation between the presence of facilities and the demographic composition

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of places in the late 1990s, we have little knowledge of how this situation arose. The outcome is important, but the process behind it is equally relevant in environmental justice considerations (9–10). Were these sources of environmental threats intentionally located in communities that were poor, minority, and/or politically weak? Or is there an alternative explanation, one suggesting that facilities were located without any reference to the race and economic status of communities, and that the demographics of communities with facilities simply changed over time, producing the inequity that we see today?

This paper examines some of the geographic factors involved in proving or disproving environmental justice claims. Six issues are highlighted as the most salient.

Precise Locations of Threats

The vast majority of social science studies of environmental justice use a standard correlation methodology to examine the relationship between toxic facilities and the demographics of their locations. There is an implicit assumption that the reported locations are correct. While many of the studies comment on some of the reliability issues of the EPA's Toxics Release Inventory (TRI)—the database most often used—there is rarely comment on the locational accuracy of the sites (11). In a statewide study of South Carolina using EPA databases (TRI, the National Priorities List [NPL], and the Biennial Reporting System [BRS]) for the 1987–1992 time period, we found that nearly 60% of the facilities listed were located in the wrong census block group (12). Comparing inaccurately recorded locations with accurately recorded locations can lead to widely different conclusions about the racial makeup of the surrounding community. For example, Westinghouse Nuclear Fuels Division (in Columbia, South Carolina) was improperly located on an EPA Web site that illustrated the use of geographic information systems (GIS) in environmental justice. When the site was located correctly and the concentric zones redrawn, the profile of the community changed from completely white (according to EPA) to 91% nonwhite. As Table 1 shows, there was very little percentage change in the 0- to 5-mile range, although the absolute number of potentially affected residents was lessened significantly.

Table 1 Differences in Socioeconomic Characteristics Before and After Correcting for the Location of the Westinghouse Nuclear Fuels Facility in Columbia, SC

	Block Group		0 to 1 mile		0 to 3 miles		0 to 5 miles	
	Old[a]	New[b]	Old[a]	New[b]	Old[a]	New[b]	Old[a]	New[b]
% nonwhite	0	91	25	61	36	56	38	41
% poverty	11	38	19	21	19	15	16	13
Total population	536	2,051	15,804	190	74,076	5,099	148,660	26,964
Total minority population	0	1,873	3,300	143	27,026	4,308	61,206	11,377
Density (per square mile)	1,703	14	2,043	21	1,562	185	1,366	564

[a] Demographic characteristics according to an EPA Region 4 Web site illustrating the use of GIS in environmental justice

[b] Revised demographic characteristics based on the correct location of the facility. Conducted by the Hazards Research Lab, University of South Carolina.

Choice of the Environmental Threat

The potential for scientific replication and generalization of findings is often thwarted by the lack of comparability between empirical studies. Depending on the type of threat examined (e.g., a landfill, a TRI facility, a Superfund site, actual emissions), very different patterns can be observed, leading to conflicting results in the literature. Hird (13) found that affluent counties were more likely to host NPL sites than non-affluent counties. On the other hand, no relationship between poverty and host/non-host counties was found when hazardous waste treatment, storage, and disposal facilities were examined (14).

Very few studies have been conducted comparing two different sources of threats and their spatial manifestations for particular places. In a study of the Southeast comparing acute releases (reported by the federal Emergency Response and Notification System) with more chronic releases (reported under TRI), little association with race was found (15). Wealth indicators, on the other hand, were positively correlated with releases, with TRI releases being dominant in urban areas. In an earlier study of the same region, considering only TRI emissions, Stockwell et al. (16) developed a GIS-based profiling method to delineate high-risk from low-risk counties and found that high-risk counties were correlated with population density and more urbanized places. Depending on the nature of the environmental threat, we can see radically different conclusions from the empirical literature.

Geographic Scale of Analysis

This issue of geographic or spatial scale is perhaps one of the most important issues in environmental justice research. While the scale of research studies varies widely (census block, tract, metropolitan area, county), there is no assessment or uniform opinion as to which scale is the most appropriate for proving or disproving environmental justice claims (17). Because of the aggregation bias and the modified areal unit problem (well-known spatial considerations in geography), the selection of the enumeration unit is critical in the proof. A number of studies demonstrate that the statistical results change as the geographical unit of analysis is varied (18,19). For example, there was no association between any of the three indicators examined (TRI, BRS, NPL) and the racial or economic composition of host census tracts or blocks for a study of South Carolina. However, when data were aggregated to the county level, larger numbers of facilities were associated with higher-income white counties—just the opposite of what most people expected (20).

A secondary scale issue involves the methods for stratifying the population around the facilities and the resulting classification problems. The host/non-host methodology (i.e., using statistical analyses—such as difference of means and difference of proportions tests—to compare host and non-host communities, thus ascertaining the statistical significance of facility distribution) is the most common way to differentiate the local geography. Recent research is moving toward using buffers (at varying distances from the source) as the classification tool (21–24). However, major questions arise concerning the actual interval distance to use (0.5 miles, 1 mile, etc.) and the basis for that selection (worst-case events, modeled effects, convenience). Obviously, the choice of buffer distance is an important variable in determining whether inequities exist or not.

Subpopulation Selected

Thus far, most environmental justice research has targeted two subpopulations, delineated by race/ethnicity and income levels. There are few studies that examine the disproportionate effects on subpopulations delineated by gender or age, despite very real differences in susceptibility, vulnerability, and ability to cope with and recover from environmental threats (25,26) including disasters (27).

The following example illustrates why other subpopulations should be considered in addition to those based on race/ethnic and wealth indicators. Again drawing on the experience with South Carolina, the state's block groups were categorized based on the percentage of children under 18 in each block group, compared with the statewide average for the same percentage. The comparisons were expressed as ratios. Once they were categorized as either high (>1.1), medium (0.9:1–1.1), or low (<0.9) regions, the block groups were mapped and statistically compared with the block-group locations of all TRI facilities in South Carolina, and also those TRI facilities in the state that emitted heavy metals, using a host/non-host methodology. The differences between each group were statistically significant (based on chi-square tests), as shown in Table 2. More importantly, when the sites were desegregated, we found that nine out of the top ten heavy emitters were located in block groups with greater than the statewide average of children under 18. How this relates to potential health outcomes is unclear at this time, but it does provide another perspective on who bears the burdens of toxic releases.

Table 2 Children and the Location of Toxic Facilities in South Carolina, 1990

Block Group Characterization for Children <18 Years[a]	Percentage of Top 100 TRI Releasers in Block Group Category	Percentage of TRI Heavy Metal Emitters in Block Group Category	Number of TR Heavy Metal Emitters in Block Group Category
High	44%	45%	61
Medium	31%	28%	38
Low	25%	27%	36
Chi-square (significance)	6.08 (.0478)	10.09 (.0064)	

[a] Block group characterization (high, medium, low) is calculated as the percent younger than 18 in a block group, divided by the percent younger than 18 for the state. "High" indicates block groups with a ratio of children <18 years greater than 1.1:1, "medium" indicates a ratio between 0.9:1 and 1.1:1, and "low" indicates a ratio lower than 0.9:1.

Time Frame

As noted earlier in this paper, environmental justice research needs to address the fundamental issue of "which came first," so that we more accurately understand the processes that gave rise to the patterns that are observed today. As Greenberg (28) suggests, it is important that environmental justice research focus on both outcome (current patterns) and process. However, the process-oriented studies require detailed time-series analyses of demographic change in communities. These are difficult to perform because of limitations in historical databases, knowledge of facility start dates, and most importantly, matching historical census boundaries. However, a number of studies (10,29,30) have conducted these time-series analyses with inconclusive results. While inequities may currently exist, they came about by a process more likely explained by regional and state migration patterns, market dynamics, and unique and localized sociospatial contexts. For example, in an attempt to solve income and employment disparities within a region, states may embark on economic development plans that promote economic growth but may also promote environmental inequities. This may help to explain some of the disparities found in rural, southern states, for example, though this explanation may not address the processes giving rise to inequities in northern urban-industrial areas.

Relative Hazardousness of Spatial Units

The late 1990s have seen an increasing sophistication of environmental justice research. There is movement away from the static indicators of injustices—mere presence or absence in a community—to more consideration of the underlying processes and potential impacts of facilities and their emissions. Of critical concern are the quantity and toxicity of emissions from facilities. Secondary concerns are the spatial variability of emissions and their potential impact on local populations. While many of the existing databases (such as TRI) provide estimates of releases or emissions, there is no consistent source of data regarding the toxicity or potential health impact of these emissions. One of the biggest stumbling blocks to this line of inquiry is the lack of a consistent measure of toxicity that the social science community can use in comparing risk.

Only a handful of studies have tried to incorporate toxicity measures into environmental justice research (11,16,24,31,32). While each study used TRI data, they employed different toxicity measures, so comparability between them and generalizations from them are difficult. Much more work needs to be done in this area to develop a representation of relative risk and thus a prioritization or action.

Conclusions

This paper has described the evolution of environmental justice policy. Based on the research and empirical work to date, a number of issues or lessons have been highlighted. First, there is a critical need for spatial accuracy in the location of toxic facilities. Second, geographical scale is important because injustices may statistically exist at one scale, but disappear when using another. The optimal scale depends on the initial questions asked of the research and/or policy. Third, the choice of environmental threat, subpopulation, and time frame affect the comparability of findings and their replication. A number of important subgroups are missing from much of the research (e.g., the elderly, children). Thus far, there is little replication of results, largely due to the differences mentioned. Fourth, the current physical distribution of environmental threats may not lead to differences in potential exposures. Just because a facility is located in a minority tract, for example, does not mean that there is more potential exposure to that tract's residents. Fifth, the spatial delineation of toxicity indicators can help to define the relative hazardousness of places. Finally, and perhaps most important, the empirical "proof" of an injustice may be less important than the local perception of and sensitivity to the issue. Demanding complete certainty in the existence of environmental injustice before policy initiatives are undertaken may pose greater risks to the well-being and functioning of communities than simply responding to the perception of the threats.

References

1. Berry BJL. 1977. *The social burdens of environmental pollution.* Cambridge: Ballinger.
2. Cutter SL. 1995. Race, class, and environmental justice. *Progress in Human Geography* 19:107–18.
3. US Government Accounting Office. 1995. *Hazardous and nonhazardous waste: Demographics of people living near waste facilities.* Washington, DC: GAO/RCED-95-84.
4. United Church of Christ Commission for Racial Justice. 1987. *Toxic wastes and race in the United States.* New York: United Church of Christ.
5. Bullard RD. 1990. *Dumping in Dixie: Race, class, and environmental quality.* Boulder, CO: Westview Press.
6. Bullard RD. 1994. *Unequal protection: Environmental justice and communities of color.* San Francisco: Sierra Club Books.
7. Bullard RD. 1996. Environmental justice: It's more than waste facility siting. *Social Science Quarterly* 77 (3):493–9.
8. Bryant B, Ed. 1995. *Environmental justice: Issues, policies, and solutions.* Washington, DC: Island Press.
9. Been V, Gupta F. 1997. Coming to the nuisance or going to the barrios? A longitudinal analysis of environmental justice claims. *Ecology Law Quarterly* 24:1–56.
10. Yandle T, Burton D. 1996. Reexamining environmental justice: A statistical analysis of historical hazardous waste landfill siting patterns in metropolitan Texas. *Social Science Quarterly* 77:477–92.
11. McMaster RB, Leitner H, Sheppard E. 1997. GIS-based environmental equity and risk assessment: Methodological problems and prospects. *Cartography and Geographic Information Systems* 24(3):172–89.
12. Scott MS, Cutter SL, Menzel C, Ji M, Wagner DF. 1997. Spatial accuracy of the EPA's environmental hazards databases and their use in environmental equity analyses. *Applied Geographic Studies* 1(1):45–61.
13. Hird JA. 1994. *Superfund: The political economy of environmental risk.* Baltimore: Johns Hopkins University Press.
14. CleanSites, Inc. 1990. *Hazardous waste sites and the rural poor: A preliminary assessment.* Alexandria, VA: Clean Sites, Inc.
15. Cutter SL, Solecki WD. 1996. Setting environmental justice in space and place: Acute and chronic airborne toxic releases in the southeastern United States. *Urban Geography* 17(5):380–99.
16. Stockwell JR, Sorenson JW, Eckert JW Jr, Carreras EM. 1993. The US EPA geographic information system for mapping environmental releases of Toxic Chemical Release Inventory (TRI) chemicals. *Risk Analysis* 13:155–64.
17. Zimmerman R. 1993. Social equity and environmental risk. *Risk Analysis* 13:649–66.
18. Anderton DL. 1996. Methodological issues in the spatiotemporal analysis of environmental equity. *Social Science Quarterly* 77(3):508–15.
19. Zimmerman R. 1994. Issues of classification in environmental equity: How we manage is how we measure. *Fordham Urban Law Journal* 21:633–69.

20. Cutter SL, Holm D, Clark L. 1996. The role of geographic scale in monitoring environmental justice. *Risk Analysis* 16(4):517–26.
21. Opaluch JJ, Swallow SK, Weaver T, Wessells CW, Wichelns D. 1993. Evaluating impacts from noxious facilities: Including public preferences in current siting mechanisms. *Journal of Environmental Economics and Management* 24:41–59.
22. Glickman TS, Hersh R. 1995. Evaluating environmental equity: The impact of industrial hazards on selected social groups in Allegheny County, Pennsylvania. Discussion Paper 5-13. Washington, DC: Resources for the Future.
23. Chakraborty J, Armstrong MP. 1997. Exploring the use of buffer analysis for the identification of impacted areas in environmental equity assessment. *Cartography and Geographic Information Systems* 24(3):145–57.
24. Neumann CM, Forman DL, Rothlein JE. 1998. Hazard screening of chemical releases and environmental equity analysis of populations proximate to Toxic Release facilities in Oregon. *Environmental Health Perspectives* 106(4):217–26.
25. Cutter SL. 1995. The forgotten casualties: Women, children, and environmental change. *Global Environmental Change* 5(3):181–94.
26. Swanston SF. 1994. Race, gender, age, and disproportionate impact: What can we do about the failure to protect the most vulnerable? *Fordham Urban Law Journal* 21:577–604.
27. Fothergill A. 1996. Gender, risk and disaster. *International Journal of Mass Emergencies and Disasters* 14(1):33–56.
28. Greenberg MR. 1993. Proving environmental equity in siting locally unwanted land uses. *Risk—Issues in Health and Safety* 4:235–52.
29. Anderson AB, Anderton DL, Oaks JM. 1994. Environmental equity: Evaluating TSDF siting over the past two decades. *Waste Age* 25(7):83–100.
30. Mitchell JT, Thomas DSK, Cutter SL. 1999. Dumping in Dixie revisited: The evolution of environmental injustices in South Carolina. *Social Science Quarterly* 80(2):229–43.
31. Bowen WM, Salling MJ, Haynes KE, Cryan EJ. 1995. Toward environmental justice: Spatial equity in Ohio and Cleveland. *Annals of the Association of American Geographers* 85:641–63.
32. Perlin SA, Setzer RW, Creason J, Sexton K. 1995. Distribution of industrial air emissions by income and race in the United States: An approach using the Toxic Release Inventory. *Environmental Science and Technology* 29:69–80.